# Ft Nelson TSA

# VRI Ground Sample and Monitoring Project Implementation Plan

## DRAFT 2.0

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FOREST
RENEWAL BC

## EXECUTIVE SUMMARY

This is a draft VRI Ground Sampling and Monitoring Project Implementation Plan (VPIP) for the Fort Nelson TSA. The general objectives and assumptions in this draft plan must be reviewed and approved by the stakeholders within the next several months. Following approval, the sample files must be assembled and the plan finalized.

The objectives of this plan are to complete VRI ground sample activities, analysis and inventory file adjustment in time for TSR 3. This plan does not address any ground sampling activities after TSR 3. The schedule and design for completing the monitoring component of this of this plan requires further review.

The VRI ground sampling target population is the Vegetated Treed (VT) portion of the TSA, excluding parks and other legally recognized protected areas. The VRI ground sampling will be targeting two primary populations; the VT within the new VRI photo-interpreted and older Forest Inventory Planning (FIP) areas. The sampling within the new VRI photo-interpreted area will target 2 specific strata; black spruce leading stands and other VT types. The older FIP area will proportionally sample all forest types. Sample polygons will be selected using stratified probability proportional to size with replacement (PPSWR) sampling, with the strata based on forest type (leading-species groups) and total polygon volume.

The suggested monitoring project will proportionally select and sample 50 of the VRI samples established within the new VRI photo-interpretation area within the "other " strata following the current Change Monitoring sampling protocols.

The inventory will be implemented in two stages. In the first stage 125 VRI sample clusters will be installed during the first year of sampling (2002). In the second stage, 75 VRI sample clusters, 50 monitoring plots and 90 NVAF trees will be established. The data will be compiled/analyzed and the inventory files adjusted for TSR 3. The *estimated* total cost of the first stage is approximately $350,000. This cost includes installation of the VRI sample clusters and preliminary statistical analysis. The costs for the second year, including ground sampling, final analysis and inventory file adjustment are approximated to be $350,000. Total costs are estimated at $750,000.

## Table of Contents


**EXECUTIVE SUMMARY** ..... I

**1. INTRODUCTION** ..... 1

*1.1 BACKGROUND* ..... 1

*1.2 RATIONALE* ..... 1

**2. SAMPLING PLAN** ..... ERROR! BOOKMARK NOT DEFINED.

*2.1 OVERVIEW* ..... ***ERROR! BOOKMARK NOT DEFINED.***

*2.2 LANDBASE* ..... 2

*2.3 INVENTORY OBJECTIVES* ..... 3

*2.4 TARGET POPULATION* ..... 5

*2.5 SAMPLE SIZE* ..... ***ERROR! BOOKMARK NOT DEFINED.***

*2.6 SAMPLE SELECTION* ..... 6

*2.7 MEASUREMENTS* ..... 6

*2.8 NET VOLUME ADJUSTMENT FACTOR SAMPLING* ..... 7

*2.9 WITHIN POLYGON VARIATION SAMPLING* ..... 8

**3. IMPLEMENTATION PLAN** ..... 9

*3.1 OVERVIEW* ..... 9

*3.2 SCHEDULE – SPRUCE STANDS* ..... ***ERROR! BOOKMARK NOT DEFINED.***

*3.3 SCHEDULE – REMAINING AREA* ..... 10

*3.4 SAMPLE PACKAGES* ..... 10

*3.5 PROJECT SUPPORT* ..... 10

*3.6 FIELDWORK* ..... 10

*3.7 QUALITY ASSURANCE* ..... 10

*3.8 DATA COMPILATION, ANALYSIS, AND ADJUSTMENT* ..... 11

*3.9 ROLES AND RESPONSIBILITIES* ..... 11

*3.10 APPROXIMATE COSTS* ..... 12

*3.11 MONITORING* ..... 12

**4. APPENDIX A – GLOSSARY OF TERMS** ..... 13

**5. APPENDIX B - SAMPLE SELECTION** ..... 17

**6. APPENDIX C - LIST OF SAMPLE POLYGONS (SPRUCE) FOR 2000** ..... 19

**7. APPENDIX D: LIST OF ALL SAMPLES IN THE VT LANDBASE** ..... 21

**8. APPENDIX E - COMPARISON BETWEEN THE POPULATION AND THE SAMPLE POLYGONS** ..... 22

**9. Appendix E – VSIP BUSINESS ISSUES** .....

Table 1. Interim Ft. NelsonTSA landbase. ..... 3

Table 2. Estimated Sample Strata and Sample Sizes ..... **Error! Bookmark not defined.**

Table 3. Recommended NVAF Sample Size. ..... **Error! Bookmark not defined.**

Table 4. Estimated minimum sample sizes and costs for VRI Ground Sample Inventory and Monitoring ..... 12


## List of Figures

Figure 1. Decreasing sampling error with increasing sample size.....5
Figure 2. Distribution of target and sample populations by site index class and age class.....22

# 1. INTRODUCTION

## 1.1 Background

A Strategic Vegetation Resources Inventory Plan (VSIP) was completed for the Ft. Nelson TSA in Jan 1999. The plan outlined the VRI photo-interpretation and ground sampling activities that were required to provide statistically valid timber volumes and other tree attributes for the Ft. Nelson TSA to support TSR 3. In support of this project a 5 Year Plan and a Partnership Agreement were signed between Slocan Forest Products, the Ministry of Forests and FRBC.

To date approximately 3 million hectares in the Ft Nelson TSA as undergone a VRI photo-interpretation inventory. In order to meet the objectives of the original plans, VRI ground sampling activities are required for 2002/03.

This draft VRI Project Implementation Plan (VPIP) outlines the VRI ground sampling and monitoring projects in the Fort Nelson TSA. The VRI ground sampling project priority is to sample two populations. The first population represents the VT area that has undergone a recent VRI photo-interpreted inventory. The second area represents the existing older FIP based VT forest cover inventory. The monitoring plan seeks to enhance 50 VRI plots with fixed area samples within the new VRI photo-interpreted area, excluding stands leading in black spruce (Sb).

The Ministry of Sustainable Resource Management (MSRM) Terrestrial Information Branch (TIB) prepared this Draft VPIP in consultation with the Ministry of Forests (MoF) and MSRM Regional and District staff and Slocan Forest Products. A glossary of terms is provided in Appendix A.

## 1.2 Rationale

The VRI Ground Sampling is needed in the Ft. Nelson TSA to provide statistically valid data to adjust the existing forest cover attributes and provide information to support sustainable forest management practices. Information from the monitoring project will provide an independent check on the projected change or growth in vegetation, within the TSA.

The business needs driving this plan have come largely from the 1996 and 2000 Timber Supply Reviews. For reference, appendix F provides a summary of the 1999 VSIP business rationales. In addition, the

March 2000 Fort Nelson Timber Supply Area Analysis Report March 2000 highlighted the following additional forest cover inventory issues:

i) Poor Black spruce species-specific stratification, questionable merchantability and water table related regeneration issues.

Uncertainty in:

ii) both coniferous - and deciduous - leading mixed wood stand merchantability.

iii) Site index merchantability thresholds

iv) Volume estimates for existing and regenerated stands

v) Post harvest regenerated site index (improvement in SIBEC tables)

In addition to the above , the following issue was identified:

- MGM calibration[1]: the need to collect stand table information to calibrate the Mixed Wood Growth Yield model have also been identified as a critical issue.

### 1.3 Landbase

The Fort Nelson TSA covers over 8.2 million hectares of which currently 4.2 million hectares is considered productive forest and of which about 925,000 hectares are considered available for timber production and harvesting. The information for this summary was provided from the BC MSRM FIP files used in the March 2000 Timber Supply Analysis.

For interim VRI ground sample and monitoring planning purposes approximately 3 million hectares of the total Fort Nelson area is in parks and protected Areas, leaving approximately 5 million hectares as managed forest. Of this 5 million hectares approximately 3 million has recently undergone a new VRI photo-interpreted inventory leaving approximately 2 million hectares in the old FIP format inventory. (See table 1)

As the new VRI photo-interpreted inventory and file processing has not been completed, it would be inappropriate to at this time to provide a ground sample planning, species – age - site class summary based

[1] Personal correspondence with Doug Beckett and George Harper. MoF

on the existing FIP data. Instead, for interim planning purposes, an approximation, based on expert[2] knowledge was made on the relative species distribution within the TSA. Once data processing of the new VRI files has been completed and the existing FIP files have been converted to VIF format, a complete land base summary will be produced.

Table 1. Interim Fort Nelson TSA landbase.[3]

| Land Classification | Area (ha) | % |
|---|---|---|
| Crown forest land | 8,000,000 | 100.0 |
| Parks and Protected Areas | 3,000,000 | 37.5 |
| New Veg Photointerp Area | 3,000,000 | 37.5 |
| FIP Area | 2,000,000 | 25.0 |

## 1.4 VRI Ground Sampling Inventory Objectives

The original VRI ground sampling objectives of the 1999 FT.Nelson VSIP were to:

> *"Install a total number of VRI samples clusters that will aim to achieve a sampling error of ±10% (95% probability) for net timber volume in the vegetated treed population of the District"*

After further review of the 1999 VSIP, coupled with experience gained in conducting other VRI ground sampling projects it is recommended that the original VSIP ground sampling priorities should be modified.

This plan recommends the following VRI ground sampling, strata specific objectives:

> *Objective 1: Sample the VT portion of the new VRI photo-interpreted area, excluding Sb leading stands in order to achieve a sampling error of ±12% (95% probability) for net timber volume. This area represents the majority of the current and potential THLB within the new VRI photo-interpretation area. It is expected that forest cover attributes will be adjusted following the completion of this study.*

> *Objective 2: Sample the VT portion of the new VRI photo-interpreted area, leading in Sb only, in order to achieve a sampling error of ±40% (95% probability) for net timber volume. The majority of this area is not in the current, nor is likely to be in the foreseeable future timber*

[2] Laurence Bowdige, MSRM , TIB

[3] Area estimates provided by Laurence Bowdige.

*harvesting land base. Due to the high degree of variation in these stands, [4]and hence the high sampling costs, it is recommended that the results of this objective are used to assess the general reliability of the inventory and explore other sampling opportunities. Stakeholders will need to carefully review the results of this study and decide if they wish to adjust this component of the inventory or install additional samples to reduce the overall risk and uncertainty.*

*Objective 3: Sample the VT portion of the old FIP based photo-interpreted area in order to achieve a sampling error of ±25% (95% probability) for net timber volume. This area represents a large amount of the current and future THLB, however due to the poor level of species specific and general stratification it is recommended that only enough samples are established to assess the general reliability of the current inventory. Stakeholders can decide if they wish to adjust the inventory with this data or use it in sensitivity analysis in TSR 3. It is expected that the majority of these samples can be used in additional VRI sampling projects.*

Given the size of the Ft Nelson TSA, sampling costs and marginal timber opportunities in much of this management unit, this plan does not specify a specific overall target sampling error for the entire VT population. Following the strata based ground-sampling activities an overall weighted sampling error can be calculated. (see section 1.6 for sample size details) It is expected that an overall sampling error for the entire area of approximately 15% @ 95% level of probability would be achieved. This assumption must be verified after the first year of sampling.

Net timber volume is gross volume minus stumps, tops, decay, waste, and breakage. Decay and waste are estimated using VRI call grading/net factoring and NVAF sampling. Standards for the use of net factoring and NVAF versus the 1976 loss factors are currently under review within MSRM.

## 1.5 Monitoring Sampling Objectives:

Change Monitoring is the process of observing changes and trends over time in the level of the forest resource and change in the land cover classification between two or more time points. Information from the monitoring project will provide an independent check on the projected change or growth in vegetation, within the TSA.

With the recent interest in change detection for the assessment of sustainability, monitoring protocols are being developed that will provide indicator data to assess sustainability and other emerging issues. This is

[4] The Dawson Creek VRI CV for Sb was 118%

an evolving process and as new protocols are developed, they will be made available with appropriate documentation and field procedures. At present, only the Provincial Change Monitoring (PCM) Program has been established as a RIC standard.

*This plan recommends that proponents follow the ongoing development of the monitoring program and consider establishing ground sample monitoring plots in the second year of sampling. It is suggested that proponents consider budgeting for the enhancement of 50 VRI sample plots to CMI monitoring standards within the VT portion of the new VRI photo-interpreted area. additional sampling could be completed in subsequent years.*

## 1.6 VRI Ground Sample Target Populations and Sample Sizes

The target populations are the VT portions of the TSA, outlined in section 1.4 excluding parks and other officially protected areas. The MSRM TIB official file will be used for sample selection.
To meet the inventory objectives (section 1.4), and recognizing the funding and timing constraints, a minimum sample size of 175 VRI sample clusters is recommended for the 2 primary populations.

The following table is presented to demonstrate the effect of population variation (CV) and sample size. Based on the Dawson Creek VRI ground sample analysis the CV for Sb is in excess of 100%, while Pl and Sw CV are approximately 50%.
( Figure 1).

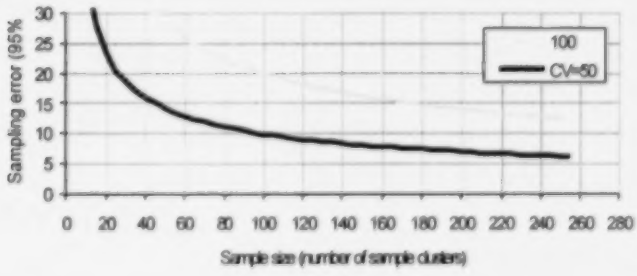


Figure 1. Decreasing sampling error with increasing sample size.[5]

The following table indicates the specific strata and suggested sample sizes. These areas and proportions must be verified from the new VRI photo-interpreted and existing FIP inventory.

[5]The CV, or coefficient of variation, is estimated from the Dawson Creek VRI ground sampling project.

**Table 2: Estimated Sample strata and sample size.**

| *Population* | *Area (ha)* | *Sample size* | *Expected sampling error @ 95%* | *CV* |
|---|---|---|---|---|
| | | | | |
| **New VRI** | 3,000,000 | | Unknown | Unknown |
| | | | | |
| **(Sb)** | 1,500,000 | 25 | 40% | 100% |
| | | | | |
| **(Other)** | 1,500,000 | 100 | 12% | 60% |
| - pure PL | (75,000) | (5) | | |
| - pure S | (225,000) | (15) | | |
| - pure At/Ac | (225,000) | (15) | | |
| - all other / mixed wood | (975,000) | (65) | | |
| | | | | |
| **Old FIP** | 2,000,000 | 50 | 23% | 80% |
| | | | | |
| - Sb leading | 1,000,000 | 25 | | |
| - pure PL | (50,000) | (1) | | |
| - pure S | (150,000) | (4) | | |
| - pure At/Ac | (150,000) | (4) | | |
| - all other / mixed wood | (650,000) | (16) | | |

## 1.7 Sample Selection

Sample polygons will be selected using the stratified probability proportional to size with replacement (PPSWR) sampling methodology using the existing official MSRM VIF files. At this time, approximately 550 or 85% of the map files have been processed and are ready for sample selection. It is critical the remaining files are available for sample selection by April. (Appendix C will list the sample polygons when available.).

Stratification will be based on leading species and polygon volume per hectare as per table 2. Sample allocation to individual leading-species strata and substrata was proportional to strata or sub-strata areas. PPSWR will be applied to each sub-stratum.

## 1.8 Measurements

VRI certified crews will be used to gather data – measure timber attributes. Data will be collected following the current VRI *Ground Sampling Manual*. The following Card Types will be used: 1-3, and 8-12.

To assist in determining Sb harvesting opportunities (moisture) and enhancing the SIBEC tables it is suggested that site series and soils data is also collected.

To assist in providing stand table information for the Mixed Wood Growth Model (MGM), TIB was advised by Dr. Steve Titus of the University of Alberta to also collect stand layer *age* data for all mixed wood and pure deciduous type ground samples. Due to the difficulty in developing unbiased sampling methods to assess multi-layer stand attributes, the current VRI procedures do not specify how to collect this information. Multi-layered stand age information is not currently accepted within the VRI ground sample validation/database. Proponents will have to work with MSRM staff in developing these procedures. At this time it not expected that this data will be entered within the TIB database.

### 1.9 Net Volume Adjustment Factor Sampling

NVAF sampling involves detailed stem analysis of sample trees, calculation of actual net volume, and calculation of the ratio between actual net volume and estimated net volume (where estimated net volume is obtained from net factoring and taper equations). Net factoring and NVAF are replacing the existing 1976 loss factors currently used in inventory file volume assignment.

NVAF sampling is currently optional, however the collection of this information is highly recommended. We suggest a total minimum, non species-specific NVAF sample size of 90 trees. The following NVAF tree distribution is suggested in table 3.

Table 3: Recommended minimum NVAF sample size.

| Primary Population | Sub-population | Stratification | Sample size |
|---|---|---|---|
| | | | |
| **New VRI** | | | |
| | **Other** | Mature | 30 |
| | (At/AC:Pl:S;Mixed wood) | Immature | 15 |
| | | Dead | 5 |
| | **Sb** | Mature | 10 |
| | | | |

| | | | |
|---|---|---|---|
| **Old FIP** | All VT | Mature<br>Immature | 20<br>10 |
| | | *Total* | *90* |

## 1.10 Within Polygon Variation Sampling

No WPV sampling is planned at this time. WPV sampling provides information to estimate individual polygon error, assessed as the difference between adjusted polygon value and "true" value for that polygon based on intensive sampling of sample polygons.

# 2. IMPLEMENTATION PLAN

## 2.1 Overview

*The stakeholders have numerous options available with respect to the implementation of this plan. The primary risk driving the implementation of this plan is the availability of continuos funding over the 2 year period and the need to ensure that at the end of each sampling season, statistically valid results are available.*

This plan recommends a two-stage approach; proportionally sampling all populations in the first year, analyzing the results and revising sample sizes if needed. The remaining samples, NVAF and analysis/file adjustment would be completed in the second year.

This option will ensure that statistically valid results will be available at the end of the first year. The disadvantage to this approach is that field sampling logistics may not be optimized, leading to slightly higher sampling costs.

## 2.2 Schedule Stage 1 (01/02)

The VRI will be implemented as follows:

1. Finalize this draft plan objectives (Dec) (TIB)
2. Obtain new VIF files and FIP files (Jan 02) ?
3. Load VIF files and finalize PIP/ Create spatial files. (Feb) ?
4. Obtain Stakeholder approval. (March) ?
5. Select sample locations in polygons using GIS (April) (MSRM PG Region/District)
6. Prepare sample packages; each to include photo stereo-pair for access, document photo photocopies, sample cluster location map (1:10,000), and access maps (1:20,000) (March ) (MSRM PG Forest Region/District).
7. Tender and select contract crews, and award contracts (April) (MSRM PG Forest Region).
8. Conduct quality assurance (10% check) (June-September) (MSRM PG Forest Region).
9. Validate and compile data from completed sample clusters and perform interim analysis / confirm preliminary sample size estimates. (October). ?

10. If needed, revise VRI Ground PIP. Finalize Monitoring component. (Nov) ?

### 2.3 Schedule – Stage 2 (02 / 03)

11. Finalize Monitoring Plan / Select and prepare samples (Non 02) ?
12. Tender and select contract crews, and award contracts (April) (MSRM PG Forest Region)
13. Complete 2nd year of VRI and NVAF sampling. (Sept 03) (?)
14. Conduct quality assurance (10% check) (June-September) (MSRM PG Forest Region).
15. Validate and compile data from completed sample clusters and perform final analysis / adjust inventory files / prepare final report.(October). ?

### 2.4 Sample Packages

Field sample packages should include most current photo stereo-pairs for access, copy of document photo (where possible), sample cluster location maps (1:10,000), and access maps (1:20,000) clearly indicating sample cluster location and polygon boundaries; and overview maps (1:250,000) for general polygon location. Maps will be plotted showing the VRI grid overlays and selected sample locations. Sample locations within a polygon will be selected using GIS.

### 2.5 Project Support

The MSRM will provide aluminum stakes, field maps, photos, and field cards to the contract crews. Provision of other equipment such as GPS will be the responsibility of the contract crews.

### 2.6 Fieldwork

Fieldwork will be completed using VRI measurement protocols and VRI certified crews (timber and ecology). The VRI Card Types 1-3 and 8-12 will be completed according the VRI Ground Sampling version 4 or later. MSRM Region and District will manage the fieldwork contracts and ensure data quality. Note that the collection of site series data (Card Type 12) will also require VRI certified (ecology) crew.

### 2.7 Quality Assurance

Quality assurance must be conducted. The VRI quality assurance standards require inspection of at least 10% of the samples. The field crews are responsible for the quality control of their own work.

## 2.8 Data Compilation, Analysis, and Adjustment

The TIB will complete data compilation; contract field crews will do data entry. Stakeholders will complete the statistical analysis and database adjustment.

## 2.9 Roles and Responsibilities

***Ministry of Sustainable Resource Management***

The MSRM will:

**Requires further review!**

- Select the sample polygons (TIB).
- Select sample locations within polygons (TIB).
- Prepare all sample packages (PG Forest Region/District)
- Mentor NVAF crews (TIB/PG Region).
- Conduct NVAF quality assurance (TIB/PG Region)
- Conduct sample cluster quality assurance (PG Forest Region)
- Check data after initial compilation (PG Forest Region).
- Validate and compile data (TIB).
- Provide attribute files and minimum standards for statistical analysis (TIB.
- Prepare and sign-off Standards Agreement and Schedule A (Agreement between Slocan Forest Products Ltd.) and the MSRM Prince George Regional Office.)
- Award fieldwork contracts (PG Forest Region)
- Provide mentor for field crews at the start of fieldwork. (PG Forest Region).
- Coordinate project activities, and ensure all contractors are qualified and certified; and tender and manage fieldwork contracts (PG Forest Region).
- Assess access and coordinate the use of helicopters (PG Forest Region).
- Identify access routes and potential tie points (PG Forest District/Region).
- Ensure sample packages are assembled and complete (PG Forest Region)
- Ensure quality assurance (QA) is complete (PG Forest Region).

***Field work contractors***

- Complete field sampling.
- Conduct internal quality control.
- Enter the sample data.

***Check-cruiser*** (PG Forest Region)

- Complete QA work for 10% of the VRI samples, and issue quality certificates.

- Complete call grading/net factoring of the NVAF samples (contractor) (*optional*).
- Enter the sample data.
- Prepare the QA report.

## 2.10 Approximate Costs

Estimated sample sizes and costs for the Ft. Nelson VRI ground sample and monitoring project are listed in table 4. The estimated total cost for sampling is approximately $ 750,0000.

Table 4. DRAFT estimated minimum sample sizes and costs for the VRI ground sample inventory and monitoring in the Ft. Nelson TSA.

| VRI Activity | Sample size (clusters) | Unit Cost ($) | Total Cost ($)t |
|---|---|---|---|
| VRI Ground Sampling | 175 | 2500 | 437,500 |
| NVAF cruising/sampling | 90 | 800 | 72,000 |
| Monitoring | 50 | 2500 | 125,000 |
| QA | 18 | 1500 | 27,000 |
| Analysis/Report/File adjustment | | | 60,000 |
| total | | | 721,500 |

## 2.11 Monitoring

The TIB is responsible for monitoring this VPIP and its approval (Appendix F).

# 3. APPENDIX A – GLOSSARY OF TERMS

## Ground Sampling

Ground sampling is the field measurement of timber, ecology, range, and/or coarse woody debris values at one or more locations within each sample polygon. Sample polygons are selected proportional to their area from a sorted list. To accommodate a wide variety of resources, various types and sizes of sampling units (e.g., fixed and variable plots, transects) are used to make the measurements.

## Inventory Unit

An inventory unit is a geographic area such as a TSA or TFL which contains the target population. A sampling error and given level of probability (risk) is determined by the stakeholders.

## Landcover Classification

The BC Land Cover Classification Scheme (BCLCS) was designed specifically to meet VRI requirements, in addition to providing general information useful for "global vegetation accounting" and "integrated resource management." The BCLCS is hierarchical and reflects the current state of the landcover (e.g., presence or absence of vegetation, type and density of vegetation) and such fixed characteristics as landscape position (i.e., wetland, upland, alpine). There are two main classes of polygons: Vegetated and Non-Vegetated.

## Management VRI

Management VRI are specialized inventories that provide detailed information required for specific resource management, i.e., day-to-day forest management. One or more VRI sampling procedures may be used for management inventories. Management inventories may focus on specific resource types (e.g., timber, range, ecology), geographic areas (e.g., landscape unit, TFL), attribute sets (e.g., Douglas-fir leading stands, age class 4+). They may use one or more of the following tools (e.g., photo-interpretation, ground sampling, NVAF sampling).

## National Forest Inventory (NFI)

The NFI provides information on Canada's resources across all provinces and allows the Federal Government a consistent framework for reporting on Canada's inventory. The inventory unit for the NFI is the entire country, although it is implemented province-by-province.

## Net Volume Adjustment Factor (NVAF) Sampling

NVAF sampling provides factors to adjust net tree volume estimated from net factoring and taper equations. The adjustment accounts for hidden decay and possible taper equation bias. NVAF sampling involves detailed stem analysis of sample trees, calculation of actual net volume, and calculation of the ratio between actual net volume and estimated net volume (where estimated net volume is obtained from net factoring and taper equations).

## Photo-Interpretation

Photo-interpretation involves subjective delineation of polygons and photo estimation of attributes for all polygons in an inventory unit. Medium scale aerial photographs (1:15,000) are most often used in photo-interpretation. However, if existing photo-based inventory is acceptable, the database can be translated into VRI format and upgraded to include the additional VRI attributes.

## Post-Stratification

Post-stratification involves dividing inventory unit into mutually exclusive sub-populations (strata) *after* ground sampling has been completed. Samples that fall in each post-stratum are analyzed separately and the results are applied to the corresponding population post-strata to improve the precision of the inventory's overall averages and totals.

## Pre-Stratification

Pre-stratification divides an inventory unit into mutually exclusive sub-populations (strata) *before* ground sampling to provide estimates for specific areas, or to increase the confidence in the overall estimates by considering special characteristics of each stratum.

## PPSWR (Probability Proportional to Size With Replacement)

This is a sample selection method in which samples (polygons) are selected with probability proportional to their size. That is, the larger polygons have a higher chance of being included in the sample.

## Resource-Specific Interpretations

Resource-Specific Interpretations (RSI) use the Resource Inventory Committee (RIC) standard VRI baseline data products (provincial VRI or management inventory), in combination with other data sets and analysis (outside of that required to produce VRI), to produce information to address specific-resource

management issues (e.g., TSR review, important ecosystems, important habitats). These interpretations include ecosystem interpretations and habitat interpretations.

## Retrofit

Retrofitting is the process of translating and upgrading an existing photo-based inventory to VRI standards. If the polygon linework and attributes are of acceptable quality, the existing FIP (Forest Inventory Planning) databases are translated to VIF (Vegetation Inventory Files) databases and the additional attributes required by the VRI are re-estimated from aerial photographs.

## Sample Size

The sample size for an inventory is the minimum number of ground samples to be established in an inventory unit to meet the target precision.

## Statistical Analysis

Statistical analysis is the process of adjusting the values of the photo-interpretation variables using ground sampling observations. For each sampled polygon, ground observations are compared to photo-estimated values to develop an adjustment factor. This factor is then applied to all polygons in the photo interpretation database to produce the final adjusted database.

## Sub-unit

Sub-unit describes the inventory unit of a management inventory (i.e., the management inventory target population is a subset of the provincial VRI inventory unit). A sub-unit may be defined by a specific geographic area (e.g., operable landbase) or stand type (e.g., problem forest types) within the Forest District.

## Target Precision

Target precision is the amount of sampling error in the key attributes (e.g., timber volume) desired in the final results.

## Vegetation Resources Inventory (VRI)

VRI is an improved vegetation inventory process for assessing quantity and quality of BC's vegetation resources. The VRI process is designed to include a flexible set of sampling procedures for collecting vegetation resource information. The VRI is essentially a toolbox of procedures, which include:

- *Photo-interpretation*: the delineation of polygons from aerial photography and the estimation of resource attributes.
- *Ground sampling*: the establishment of plot clusters in selected polygons to measure timber, ecological, and/or range attributes.
- *NVAF Sampling*: stem analysis sampling of individual trees for net volume adjustment.
- *WPV Sampling*: intensive sampling of selected polygons to determine the error between the estimated attribute values and the "true" attribute values.
- *Statistical Adjustment*: the adjustment of the photo-interpreted estimates for all polygons in an inventory unit or management unit using the values measured during ground sampling.

The VRI can be deployed over the entire province (provincial VRI) measuring timber and non-timber resources, or over a large management unit (management VRI) measuring selected resources in specific portions of the landbase. The VRI sampling process produces spatial and non-spatial databases that can be used in multiple resource management applications including timber, ecosystem, and wildlife habitat management.

## Within Polygon Variation Sampling

WPV sampling provides information for expressing the true individual polygon error, assessed as the difference between the adjusted polygon value and the "true" value for that polygon. The "true" value for the polygon is an estimate derived from a small sample of polygons that are intensively sampled on the ground.

# 4. APPENDIX B - SAMPLE SELECTION

This section documents the steps used in sample selection. The following material is presented for example purposes only.

The data inventory data (population list) for _____ is now ready for sample selection. The VRI sampling plan for this district has unique characteristics. It calls for the implementation of _____ to be completed.

The following steps should be followed in the sample selection process:

1. Assemble all polygons constituting the population eligible for sample selection.
2. Classify the population list into the following strata and substrata:
   a) non vegetated polygons(N_V)
   b) vegetated non-treed polygons (V_N_T)
   c) vegetated tree polygons (V_T)
      i) within the V_T stratum stratify by leading species
      ii) within each leading species, sub-stratify polygons by size of average volume/ha
3. Compute total area of all polygons belonging to each of the strata, and sub-strata specified above.
4. Determine sample allocation for the ____???? district VRI samples for all strata
5. For the V_T stratum, determine sample allocation for __ samples.
6. For the ____ stratum, sum the allocations based on the district VRI and the allocation based on the TEP sample. Determine how many additional samples are required to make up the required 45 samples.
7. For the other species, sum the district VRI and the TEP sample allocations.
8. After obtaining total allocations, select the specified samples from each of the strata listed in 2 above. This can be accomplished in one SAS run. Alternatively, it can be accomplished in two SAS runs, one for the Non Vegetated and vegetated non-treed, and the second for the vegetated treed.
9. After the selection, a random selection process should be used to determine district VRI samples in among the TEP samples.
10. Within the spruce stratum, a random selection process should be used to identify the additional samples that were required to make up the allocated 45 samples.

In step #8 the selection of samples should be proportional to polygon area. The process takes place as follows:

a) create a new attribute in the population data to contain accumulated polygon areas.
    i) For the N_V and V_N_T strata, the accumulation should be undertaken separately for each of the two strata. The accumulation should be from the first to the last polygon in the stratum.
    ii) For the V_T, the accumulation should be by "volume class" within each leading species.
b) Using the sample allocations determined in step 7 above, generate random numbers between 0 and the total area of a volume class of interest. The number of random numbers should be equal to the number of allocated samples.
c) The random numbers and the accumulated polygon areas will identify the sample polygons. A polygon is selected if a generated random number is larger than the accumulated area of the polygon preceding it, but is smaller or equal to its own accumulated area.
d) A file of selected polygons is created.

These steps describe the complete process for sample selection for Prince George District. Please contact me (Sam Otukol) if there are steps that need clarification.

# 5. APPENDIX C - LIST OF SAMPLE POLYGONS FOR 2000 EXAMPLE ONLY

| Sample # - | Leading Species | Area (ha) | BCLCS | MAP_NO | POLYGON |
|---|---|---|---|---|---|
| 254 | S | 85.88 | VTUTCOP | 093i016 | 0255 |
| 250 | S | 30.44 | VTUTCOP | 093j006 | 0657 |
| 55 | S | 67.80 | VTUTCSP | 093j076 | 0083 |
| 256 | S | 41.72 | VTUTCOP | 093h086 | 0234 |
| 271 | S | 22.36 | VTUTCOP | 093g060 | 0669 |
| 246 | S | 67.20 | VTUTMSP | 093h051 | 0489 |
| 248 | SB | 20.20 | VTWTCOP | 093j067 | 0347 |
| 258 | S | 29.76 | VTUTCOP | 093h096 | 0280 |
| 261 | SW | 79.68 | VTUTCSP | 093j059 | 0489 |
| 255 | S | 47.32 | VTUTCOP | 093o010 | 0309 |
| 67 | S | 144.48 | VTUTCOP | 093h035 | 0163 |
| 56 | S | 114.80 | VTUTCSP | 093i004 | 0278 |
| 266 | S | 44.80 | VTUTCOP | 093h044 | 0381 |
| 252 | S | 293.76 | VTUTCSP | 093j054 | 0243 |
| 272 | S | 5.20 | VTUTCOP | 093j097 | 0698 |
| 243 | S | 10.48 | VTUTCSP | 093j080 | 0328 |
| 247 | S | 34.16 | VTUTCSP | 093i024 | 0529 |
| 60 | SW | 2.32 | VTUTCOP | 093j086 | 0061 |
| 257 | SW | 22.36 | VTUTCOP | 093j048 | 0829 |
| 62 | S | 218.76 | VTUTCOP | 093i044 | 0336 |
| 57 | SW | 9.36 | VTUTCSP | 093j063 | 0273 |
| 270 | S | 28.76 | VTUTCOP | 093g058 | 0535 |
| 265 | SW | 7.08 | VTUTCOP | 093j068 | 0175 |
| 262 | S | 18.00 | VTUTCOP | 093h062 | 0444 |
| 251 | S | 47.88 | VTUTCSP | 093h042 | 0340 |
| 66 | S | 7.64 | VTUTCOP | 093j016 | 0392 |
| 65 | S | 59.88 | VTUTCOP | 093i033 | 0417 |
| 61 | S | 8.04 | VTUTCDE | 093j073 | 0184 |
| 69 | SW | 14.96 | VTUTMOP | 093j047 | 0627 |
| 58 | S | 279.12 | VTUTCOP | 093i051 | 0263 |
| 68 | SW | 21.88 | VTUTCOP | 093j096 | 0224 |
| 53 | S | 35.64 | VTUTCSP | 093i014 | 0729 |

| Sample # - | Leading Species | Area (ha) | BCLCS | MAP_NO | POLYGON |
|---|---|---|---|---|---|
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# 6. APPENDIX D: LIST OF ALL SAMPLES IN THE VT LANDBASE EXAMPLE ONLY

| Observ. # | Map# | Poly. # | Stratum |
|---|---|---|---|
| 1 | 093g034 | 0485 | vt pine vol.cls 2 |
| 2 | 093g042 | 0151 | TEP Pine Vol.cls 2 |
| 3 | 093g043 | 0449 | TEP Pine Vol.cls 2 |
| 4 | 093g044 | 0141 | vt pine vol.cls 2 |
| 5 | 093g044 | 0178 | TEP Pine Vol.cls 2 |
| 6 | 093g044 | 0965 | TEP Pine Vol.cls 2 |
| 7 | 093g045 | 0406 | TEP Pine Vol.cls 2 |
| 8 | 093g054 | 0332 | TEP Pine Vol.cls 2 |
| 9 | 093g055 | 0642 | TEP Pine Vol.cls 0 |
| 10 | 093g058 | 0535 | TEP Spruce Vol.cls 2 |
| 11 | 093g059 | 0147 | TEP Balsam Vol.cls 1 |
| 12 | 093g060 | 0669 | TEP Spruce Vol.cls 2 |
| 13 | 093g060 | 0825 | TEP Balsam Vol.cls 0 |
| 14 | 093g064 | 0614 | vt pine vol.cls 2 |
| 15 | 093g069 | 0122 | TEP Balsam Vol.cls 0 |
| 16 | 093g074 | 0694 | vt pine vol.cls 1 |
| 17 | 093g075 | 1055 | TEP Pine Vol.cls 1 |
| 18 | 093g080 | 0047 | TEP Pine Vol.cls 1 |
| 19 | 093g080 | 0300 | TEP Pine Vol.cls 0 |
| 20 | 093g084 | 0142 | TEP Spruce Vol.cls 2 |
| 21 | 093g086 | 0301 | TEP Pine Vol.cls 1 |
| 22 | 093g089 | 0090 | TEP Spruce Vol.cls 2 |
| 23 | 093g089 | 0848 | TEP Pine Vol.cls 0 |
| 24 | 093g090 | 0740 | vt pine vol.cls 2 |
| 25 | 093g096 | 0196 | vt Decid vol.cls 0 |
| 26 | 093g097 | 0430 | TEP Decid Vol.cls 0 |
| 27 | 093g098 | 0214 | vt Decid vol.cls 2 |
| 28 | 093g100 | 0680 | TEP Decid Vol.cls 0 |
| 29 | 093h032 | 0202 | TEP Spruce Vol.cls 2 |
| 30 | 093h035 | 0163 | vt spruce vol.cls 2 |
| 31 | 093h042 | 0340 | TEP Spruce Vol.cls 0 |
| 32 | 093h044 | 0381 | TEP Spruce Vol.cls 2 |
| 33 | 093h045 | 0267 | vt balsam vol.cls 2 |
| 34 | 093h051 | 0489 | TEP Spruce Vol.cls 0 |
| 35 | 093h052 | 0203 | TEP Balsam Vol.cls 1 |
| 36 | 093h054 | 0243 | TEP Spruce Vol.cls 0 |

# 7. APPENDIX E - COMPARISON BETWEEN THE POPULATION AND THE SAMPLE POLYGONS

**EXAMPLE ONLY**

This comparison is for the entire VT sample (Appendix D). The sample (% number of sample polygons) appears representative of the target VT population (% area) in terms of site index and age class profiles (Figure 2). The total number of sample polygons is 120 and the total area of the population is 2,184,046 ha.

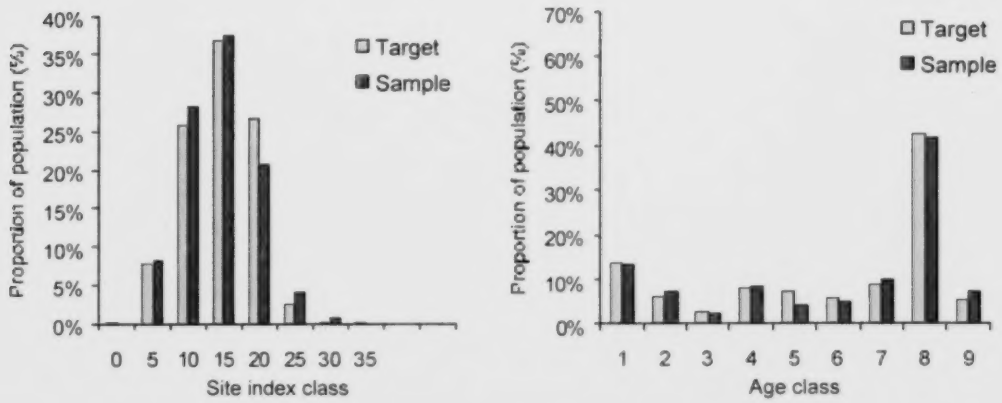


Figure 2. Distribution of target and sample populations by site index class and age class.

# Appendix F VSIP BUSINESS CONSIDERATIONS

Forest Management Issues

Priority forest management issues arising from timber supply review (TSR) 1 in the Fort Nelson TSA were reviewed (Table 2). (This table should be updated to incorporate forest management issues that will be identified in TSR 2.) An assessment of the potential use of the VRI Photo-Interpreted Estimates and the Ground Sampling is also indicated on some of these management issues. However, the table does not show the relative importance of these various issues. For example, a statistically accurate timber volume estimate may carry more weight than all other issues combined. In this case, the contribution of the VRI Ground Sampling will be quite significant.

Table 2. Forest management issues and the use of the VRI to address issues in the Fort Nelson Forest District.

| Issue[6] | VRI | | Remarks |
|---|---|---|---|
| | Photo-Interpreted Estimates | Ground Sampling | |
| 1. Reforestation: ensure that reforestation is achieved within acceptable delay standards, although it may be difficult to re-establish the coniferous species component in leading deciduous species stands. | No need | No need | |
| 2. Species mix: need to deploy silviculture methods that retain existing species mix of original stands. | No need | No need | |
| 3. Visually sensitive areas: creation of visually sensitive areas | No need | No need | |
| 4. Resource management zones (geographic areas with similar values and management). | Needed | Needed | Any new inventory may help refine the RMZs |

[6] BC Ministry of Forests, Timber Supply Branch. 1996. Forest Management Issues Identified Through the AAC Determination Process, TSA/TFL Timber Supply Reviews: 1992-1996. 31 December 1996. Victoria, BC. P.114.and BC Ministry of Forests, Fort Nelson TSA Timber Supply Review Data Package. July 1997.

| Issue[6] | VRI | | Remarks |
|---|---|---|---|
| | Photo-Interpreted Estimates | Ground Sampling | |
| 5. Riparian, biodiversity, FENs, old-growth, mature forest cover: clarify timber supply impacts and interactions. | Needed | Needed | Photo-Interpreted Estimates should improve polygon delineation, provide better age class, stand structure, and vegetation attributes, and information on soil moisture and nutrient regime to enhance the interpretation of FENs, riparian areas, seral stage and Natural Disturbance Types interpretation. Ground Sampling will provide overall District totals for coarse woody debris, stumps, potential wildlife trees, and plant lists for species diversity. The reliability of the estimates obtained for these attributes will need to be evaluated based on natural disturbance types before comparisons to the biodiversity guidelines. There is a risk that precise estimates will not be obtained for these attributes. The data set will be used to identify supplemental sampling needs.<br><br>A new Photo-Interpreted Estimates inventory is particularly important because of the age of the inventory in the District. |

| Issue[6] | VRI | | Remarks |
|---|---|---|---|
| | Photo-Interpreted Estimates | Ground Sampling | |
| 6. Protect important ecosystems and habitats for red and blue listed species, key ungulates and other regionally significant species. | Needed | Needed | The VRI is needed to support mapping important ecosystems and habitats for red and blue listed species, key ungulate ranges and other regionally significant species. The Photo-Interpreted Estimates inventory provides a spatial inventory with attributes needed to support ecosystem and habitat mapping. Wildlife habitat mapping can not be accomplished without spatial data; the products are highly relevant to forestry planning. Ground Sampling provides plant lists, forage production, and shrub transects, which can be used to support ecosystem and habitat mapping. |
| 7. Landscape-level biodiversity – incorporate all guidelines, boundaries, objectives, and prescriptions, including designated landscape units & biodiversity emphases. | Needed | Needed | The VRI can provide supporting data, e.g., potential re-definition of "old growth" based on VRI stand structure and age attributes. |
| 8. Undertake ecosystem and habitat mapping and important areas analysis to assess and protect important ecosystems and habitats for red and blue listed species, key ungulates and other regionally significant species. | Needed | Needed | VRI attributes are utilized in ecosystem and habitat mapping. This mapping needs to be supported after the VRI products are produced in order to address the identified forest management issues. |

| Issue[6] | VRI | | Remarks |
|---|---|---|---|
| | Photo-Interpreted Estimates | Ground Sampling | |
| 9. Develop management practices to protect habitat. Work with Ministry of Environment to undertake appropriate forest management practices on important habitats and ecosystems. | Needed | Needed | Rationale for this statement is included in all of the above items. In particular, wildlife habitat spatial information provides a needed inventory-based approach for identifying critical areas and habitat features for wildlife and working with forest managers to protect important ecosystems and habitats. |